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ROTARY CUTTING UNIT

Inventor: René Langhans

Cross-Reference to Related Application

application is a continuation of 08/612,212 filed 3/6/96, now abandoned, which

This is a continuation-in-part of application Ser. No. 08/182,074 filed January 13, 1994 and now abandoned.

Field of the Invention

This invention relates to a circular cutting unit to cut flat lengths of materials, particularly sheet metals and especially to equipment to cut flat lengths of material using several such cutting units.

Background of the Invention

Equipment of this general type is used in particular to cut sheet metal, for instance in the can manufacturing industry, although it can also be used for cutting paper and cardboard. Cutting can bodies requires extreme accuracy and cleanliness while keeping constant high outputs.

French patent document 612,303 (Marinori) discloses a paper-cutting machine with two shafts mounted in a fixed frame, individual circular blades being displaceably affixed to the shafts.

French patent document 2,340,170 (Metal Box Ltd) describes a sheet metal cutter with a series of circular blades displaceably mounted on two separate shafts.

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The two above mentioned apparatus of the state of the art share the design of mounting the circular blades on two mutually parallel and long shafts, the adjustment of the cutting width being

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implemented by axially displacing the individual circular blades. It follows that each of the cooperating pairs of circular blades must be individually adjusted on the upper and on the lower shafts and then be aligned again. Obviously such a procedure is both complex and time-consuming and, moreover, may lead to inaccuracies while there always is the danger of damage to the blades. As a rule the individual circular blades are adjusted in a hydraulic manner on the long shaft using suitable oil lines. As a result, the cutting apparatus and hence the material being cut is contaminated with oil, and this feature is highly disadvantageous when making cans.

Another drawback of equipment of the state of the art is the large size of the cutting-disk shafts which is required. In order to deliver the high pressure necessary for cutting sheet metal and because of the consequent danger of bending, especially at the center of the shaft, such a shaft must have a substantial diameter. Typically, shafts 105 mm in diameter are required to cut sheet metal. Hence, such shafts are expensive and furthermore sensitive to thermal expansion. Because the shaft diameters are large, the blade diameters also must be large, and as a result the blades evince an unfavorable, fairly shallow angle of cutting and hence generate untidy cut edges.

Summary of the Invention

An object of the present invention is to provide a circular-cutter unit for equipment cutting flat lengths of material and sheet metal, where said equipment is simple, compact, economical and low-soiling, and which is transversely displaceable as a whole so that mutual adjustment of the cooperating pair of circular blades no longer is required.

Briefly described, the invention comprises a circular cutter unit for equipment for cutting flat lengths of material, especially sheet metal, lying in a horizontal plane and having a longitudinal direction. The cutter unit includes upper and lower

circular blades both of which lie in planes perpendicular to the horizontal and parallel with the longitudinal direction. The two blades are supported by upper and lower blade shafts, respectively, which are parallel with the horizontal plane and perpendicular to the longitudinal direction, both blade shafts being rotatably and rigidly affixed in a common frame having substantially a U-shape with upper and lower legs connected by a flat yoke intersecting the horizontal plane at an acute angle. The cutter unit is releasably coupled to a driving unit having a motor, a drive for one of the blades being ~~non-positively~~ connected to the motor of the driving unit and the other blade being non-positively driven by the drive for the first blade.

~~The advantages achieved by the invention essentially are the~~ following:

-- much simplified handling of the circular blades because the cutting gap between the two circular blades need being set only once for the full service life,

-- virtually no danger concerning damage to the cutting edges for instance when adjusting or setting the circular blades because the cutting gap need be set only once, no relative displacement in either direction of the circular blades or of the blade shafts, and the circular blades remaining fixed in place during the entire service life,

-- much reduced conversion time because the time-consuming setting and monitoring of the cutting gap is eliminated, because instead of one blade a pair of blades can be positioned in one step, no relative displacement in either direction of the circular blades or of the blade shafts being required, and the circular-cutter units being adjustable in fully automated manner,

-- much increased availability and increased production output of the cutting unit as a whole on account of reduced conversion times, rapid exchange of a worn

circular-cutter unit by a spare one, simple dismantling of worn parts (circular blades, transport ring etc.) because the blade shafts are not continuous, and the possibility of exchanging the worn parts and of grinding the circular blades outside the cutting equipment.

Each circular cutter unit lacks the kind of geometrically locking upper blade drive used in the state of the art and is easily and quickly exchanged as a whole so that any operational interruptions will be minimized.

-- constant, burr-free cut-edge quality thanks to the constant cutting gap, the constant overlap being reduced by 50 % and the strongly reduced shearing surface. The pressure between the two cooperating circular blades is borne by the frame enclosing them alone (rather than by long, bending shafts as in the state of the art), so the shaft diameter may be kept comparatively small. The consequently reduced blade diameter provides a steeper cutting angle resulting in ~~lower forces and hence in a neater cut edge.~~

Brief Description of the Drawings

The invention and further developments of this invention are elucidated below in relation to the partly schematic representations of several illustrative embodiments wherein:

Fig. 1 is a perspective of the circular cutter unit of the invention;

Fig. 2 is an elevation facing the direction of advance of the circular cutter unit of the invention;

Fig. 3 is a cross-section along line III-III of Fig. 2;

Fig. 4 is a cross-section along line IV-IV of Fig. 3;

Fig. 5 is a schematic of the shearing procedure in a cutter

system of the state of the art; and

Fig. 6 is a schematic of the shearing procedure of the circular cutter unit of the invention.

Description of the Preferred Embodiments

The circular cutter unit of the invention shown in Figs. 1 through 4 essentially comprises an upper circular blade 2 and a lower circular blade 4, both operating perpendicularly to the horizontal plane 10 and in the longitudinal direction 8, that is, in the plane and direction of advance of the flat length of material being introduced, for instance sheet metal for manufacturing cans.

The upper circular blade 2 is affixed to an upper blade shaft 1 and the lower circular blade 4 to a lower blade shaft 3 which both extend parallel with the horizontal plane 10 and with the transverse direction 7. The two blade shafts 1, 3 are shown in detail in Fig. 4 and are supported respectively in a play-free upper blade-shaft bearing 11 and an lower blade-shaft bearing 12. Upper blade-shaft bearing 11 is mounted in a longitudinally displaceable bush 13 to allow setting the cutting gap which is advantageously set at 0.01 to 0.02 mm for can sheet metal.

The two blade shafts 1, 3 are mounted in a common and essentially U-shaped frame 5 at a fixed distance from one another. The upper leg 51 and the lower leg 52 of frame 5 are joined by a flat yoke 53 subtending an acute angle of about 10° with the horizontal plane 10. The yoke 53 therefore is practically in the horizontal plane 10 and splits the already cut length of material into a right upper strip and a left lower strip relative to the direction of advance 8. Because blade shafts 1, 3 are short and free from substantial forces, yoke 53 may be made comparatively thin and, furthermore, a diameter of about 15 mm suffices for the blade shafts themselves.

Frame 5 includes means for displaceably supporting the frame in the form of two bushings 26 and 27 which are slideably mounted

on two guide rails 6 extending parallel to the blade shafts 1, 3 so that the frame is displaceable in the transverse direction 7, as a result of which the circular cutter unit 14 is easily moved as a whole and is easily positioned relative to other circular cutter units 15 also mounted on the guide rails 6.

Conventional mechanical clamp means (not shown) may be used for a stop function for each of the circular cutter units on guide rails 6. The circular cutter units can be positioned on guide rails 6 in the transverse direction 7 perpendicular to the longitudinal direction 8 by an electromechanical system, the travel measurement for the various units preferably being integrated. Appropriately, the resolution should be about 0.01 mm and the accuracy of positioning about ± 0.01 mm.

The feed means of the material to be cut, in particular flat lengths of materials and sheet metal, are not shown in the drawing but are known in the state of the art using conventional bench and strip insertion devices. The removal means (also not shown) of the cut materials is by conventional conveyor belts.

Circular cutter unit 14 is driven by a drive shaft 16 with an approximately square cross-section driving a gear 17 with a borehole 22 also of approximate square cross-section. Drive shaft 16 of all of the cutter units is driven by a drive unit 30 which includes an electric motor (not separately shown) or any other suitable drive means. Preferably, the drive unit is ~~a non-positive drive and is one which is~~ easily detachable from shaft 16 so that the cutter units can be individually removed from the system for adjustment and maintenance. This is an important feature because it permits the units to be individually serviced and replaced without shutting down the entire system. In sheet metal cutting apparatus, blade replacement is a common event, contrary to apparatus which is only used for cutting materials such as paper, and it is important that provision for removal of cutting units for the purpose of blade replacement be provided ~~facilitated~~.

Gear 17 engages a gear 18. At the same time, gear 18 forms the attachment flange of the integral lower blade shaft 3 to

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which the lower circular blade 4 is laterally attached. Upper circular blade 2 is attachable in the same manner to flange 21 of the upper, integral blade shaft 1.

The upper circular blade 2 is indirectly driven by the motor-driven lower circular blade 4 through frictional engagement of transport rings 19 and 20, thus forming a non-positive drive. The upper and freely rotatable transport ring 20 is opposite the lower, motor-driven circular blade 4, whereas the lower motor-driven transport ring 19 is opposite the upper, freely rotatable circular blade 2.

The cutting gap between the two circular blades 2, 4 is created and adjusted by loosening tightening screws 24 clamping the thread flanks of a slotted nut 23 against the thread flanks of the displacement bush 13 and by subsequently rotating the displacement bush 13 using a pin wrench 25. Rotation of displacement bush 13 is converted by the pitch of the play-free fine thread between the rotating displacement bush 13 and the stationary, slotted nut 23 into an adjustment motion as a result of which the cutting gap can be accurately set. In the embodiment shown, a revolution of 360° corresponds to a thread pitch of 0.75 mm.

Once the cutting gap has been set, tightening screw 24 is re-tightened, so that the set position is clamped. A cutting gap between the two circular blades 2, 4 in the range of 0.005 to 0.030 mm, preferably between 0.01 and 0.02 mm was found appropriate.

The overlap of the two circular blades 2, 4 is appropriately adjusted permanently and in this embodiment it is 0.2 mm.

Figs. 5 and 6 schematically compare the shearing procedures in one case for the cutter unit of the state of the art and in the other case for the invention. The relevant shearing parameters compare as follows.

Parameter	Fig. 5 (Prior Art)	Fig. 6 (Invention)
circular blade diameter 61	100%	41%
overlap 62	100%	40%
shearing surface 63	100%	61%
cutting time	100%	60%
sheet metal thickness 64	0.25 mm	0.25 mm
cutting angle 65	5°	7°

The comparison in percent clearly shows the reductions regarding overlap, shearing surface and cutting time as well as the enlargement of the cutting angle which can be achieved using the circular-cutter unit of the invention, which are the reasons for the much improved quality of the cut edges.